1. (8 points) Find the angle $\theta$ between the vectors $\mathbf{i} + \mathbf{j} - 2\mathbf{k}$ and $\mathbf{i} + 2\mathbf{j} - \mathbf{k}$.

\[
\theta =
\]

2. (8 points) Let $(2, 8, 3)$ be the center of the sphere $S$ and let $(-2, 5, 4)$ be a point on $S$. If

\[x^2 + y^2 + z^2 + Ax + By + Cz = D\]

is an equation of $S$, find $A, B, C,$ and $D$.

\[
A = \quad B = \quad C = \quad D =
\]
3. (8 points) Find the area of the parallelogram determined by $i + j - 2k$ and $i + 2j - k$.

area =

4. (10 points) Find the area bounded by the curves $y = e^{-x}$, $y = 1 - x$, and $x = 1$.

area =
5. (10 points) Find the projection of $a = \langle 4, 2, -1 \rangle$ onto $b = \langle -2, 1, 3 \rangle$.

\[
\text{proj}_b a =
\]

6. (12 points) Consider the parallelepiped $P$ determined by the three vectors $\langle t, 1, 2 \rangle$, $\langle 5, 2, 1 \rangle$ and $\langle 1, 1, 3 \rangle$. Find $t$ so the volume of $P$ is 2.

\[
t =
\]
7. (24 points) Consider the solid obtained by rotating the region bounded by \( y = x^2 \) and the \( x \)-axis, \( 0 \leq x \leq 2 \) about the \( y \)-axis. Set up 2 definite integrals, one using the washer method, another using the shell method, that give the volume of the solid. Then calculate the volume.

definite integral for volume using washer method =

definite integral for volume using shell method =

volume =
8. (8 points) Set up a definite integral that gives the area of the region bounded by the graphs of $y^2 - 5y - x = 0$ and $6y + 2x = 6$.

\[
\text{definite integral for area} =
\]

9. (12 points) Suppose that on June 1, 2002, a lab sample has a temperature which is given by the function $C(t) = 22 - 4\cos(\pi t/12)$, where $t$ is in hours after midnight, and $C(t)$ is in degrees Celsius. Find the average temperature of the sample between 2 AM and 4 AM on this day.

\[
\text{average temperature} =
\]